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MORNING GLORY BEES AND THE *IPOMOEA PANDURATA* COMPLEX (HYMENOPTERA: ANTHOPHORIDAE)

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Abstract.—Oligolectic bees and their association with *Ipomoea pandurata* and its allied species were studied in North America. *Cemolobus ipomoeae* was found to be closely related to *Ipomoea pandurata*; *Melitoma grisella* has been shown to be linked with *Ipomoea leptophylla*; *Ptilothrix sumichrasti* was found with *Ipomoea longifolia*. The exact relationships between each bee species and each plant species are different.

According to the literature three bee genera in the Anthophoridae, *Ancyloscelis*, *Cemolobus* and *Melitoma*, are oligolectic to the genus *Ipomoea* (Michener *in* Muesebeck et al., 1951; Michener, 1954). Two of these, *Cemolobus* and *Melitoma*, occur in the eastern United States. Moreover, Robertson (1929) suggested that these bees were probably associated with *Ipomoea pandurata* (L.) Meyer, one of the few endemic species of *Ipomoea* in the eastern United States. My study began in the summer of 1971 largely as an attempt to confirm the existence of close relationships between these bees and plants. Once oligolecty[1] was documented, the following two summers were used for field study of widely separated populations of *I. pandurata*. Patterns of insect behavior at the flowers were found to be essentially constant throughout the range of bees and plants.

Materials and Methods

Field studies were made in Florida, Georgia, South Carolina, North Carolina, Virginia, Pennsylvania, Ohio, Indiana, West Virginia, Illinois, Missouri, Kentucky and Tennessee. In addition to the field studies, herbarium material of *Ipomoea* has been examined in A, FAU, FLAS, GH, UNC, US, MO, and USF (abbreviations follow Lanjouw and Stafleu, 1959). The herbarium and field studies were augmented with various floras to provide accurate distributions (Britton & Brown, 1898; Small, 1903, 1933; Wooten & Standley, 1915; Deam, 1940; Tidestrom & Kittell, 1941; Fernald, 1950; Kearney & Peebles, 1951, 1961; Jones et al., 1955; Mohlenbrock & Voight, 1959; Gleason & Cronquist, 1963; Steyermark, 1963; Justice & Bell, 1968; Radford et al., 1968; Conard, 1969; Correll & Johnston, 1970; Wharton & Barbour, 1971; Brown, 1972; Ellis & Chester, 1973). Insects were determined with the help of Paul D. Hurd. Jr., and several other members of the Entomology Department, Smithsonian Institution as well as Mitchell (1960, 1962).

Ipomoea pandurata, Intrafloral Ecology

Robertson (1891, 1925a, 1925b, 1928, 1929) reported a series of insect visitors to *I. pandurata*. Of these only two show oligolecty to these plants: *Cemolobus ipomoeae* Robertson and *Melitoma taurea* (Say).

Oligolectic bees.—While few studies have been made of the life history of the monotypic *Cemolobus* (Robertson, 1891, 1925a, 1925b), all past and present data indicate that it utilizes pollen only from *I. pandurata*.

Cemolobus is a matinal species, although cool, foggy, or rainy mornings may cause the bees to shift their activities later in the day. Under normal weather conditions the first bees arrive at *I. pandurata* flowers between 6:30 and 7:00 AM. For about the first two hours the majority of individuals visiting the flowers are females. Males arrive later and may remain active until 12:00 or 1:00 PM.

Females enter the flowers head-first to sip nectar; pollen is collected with the legs during this time. After nectar is taken they may either back out of the tube onto the inner edge of the limb to collect pollen with the front legs, or they may turn around within the tube facing out and collect pollen. Usually there is a shift from backing out early in the day to turning around within the tube later. On a few occasions these females were seen "drumming" with the wings while sitting on the inner edge of the limb and collecting pollen with the front legs. Pollen is transferred to the scopae of the posterior legs either while on the flower limb or in the air. These normally brown females are conspicuously white with pollen as they leave the plants to return to their nests.

The scopae of each female are capable of carrying large amounts of pollen and this requires the bees to visit several flowers before they are filled. Flights from flower to flower are rapid and direct. Although no male bees collect pollen it is common for them to visit several flowers and then to perch on the corolla limb or nearby plants to clean themselves of pollen.

When the flowers open the stigmas have no pollen on them, but grains are left on the stigma by each visit. Bagged or emasculated flowers or solitary plants on the fringe of the range that are not pollinated produce no fruits, while pollinated flowers fruit abundantly.

Melitoma taurea is a member of a small American genus of bees that is known to utilize only *Ipomoea* pollen in their nests (Michener *in* Muesebeck et al., 1951; Michener, 1954, 1975). The species *M. taurea* is not specific to a single species of *Ipomoea* in the eastern United States, but has been collected at the flowers of *I. sagittata* Lam. and *I. aquatica* Forsk. (Austin, unpublished), *I. purpurea* (L.) Roth (Robertson, 1929) and *Calystegia sepium* (L.) R. Brown (Robertson, 1891). Robertson indicated that the bees were only taking nectar from *Calystegia* and not collecting pollen.

Melitoma taurea is also a matinal bee, and females often appear at the flowers of *I. pandurata* before *Cemolobus*. As with *Cemolobus* females, visits to the plants begin between 6:30 and 7:00 AM. *Melitoma* enters the floral tube head-first to sip nectar. While doing this they actively brush pollen from the anthers with their legs. Unlike *Cemolobus*, they almost invariably turn around within the corolla tube to face outward. Once they have turned around they collect more pollen and transfer it to their scopae. When the scopae are full, the females leave the plants; they later return with empty scopae.

Melitoma uses the flowers of *I. pandurata* as trysting sites. Once the females have collected pollen for about two hours, the number of males visiting the plants increases markedly. Males enter flowers much less often than do females. The most common behavior is for the males to rapidly fly from flower to flower, pausing on the limb only long enough to determine if a female is inside the tube. If no female is present, the males rapidly visit other blossoms. Once a flower is found containing a female, the male enters and copulation occurs. About one flower visit in ten is used by the males to take nectar.

Other insects.—A series of insects has been recorded by Robertson (1891, 1925a, 1925b, 1928, 1929) as visitors to *I. pandurata*; my own collections include most of these. Several of these visitors are oligolectic bees with close pollen relationships to other plants, e.g. *Peponapis* and *Xenoglossa* to *Curcurbita* (Hurd et al., 1971). Most common among the other insects visiting *I. pandurata* is *Bombus*.

Bombus auricomus (Robertson), *B. griseocollis* (Degeer), *B. vagans* F. Smith and *B. pennsylvanicus* (Degeer) (Robertson, op. cit.) visit throughout the range of the plants. I found *B. pennsylvanicus* to be the predominate species. These bees are often found taking nectar when no other insects are active, particularly on foggy or drizzly mornings. *Bombus* spp. transfer pollen frequently although they have never been seen storing it in their scopae. They do often stop to clean pollen from their body and leg hairs. Members of this genus are the only visitors seen visiting the flowers on the extreme northern limits of *I. pandurata* range.

Cemolobus, *Melitoma* and *Bombus* are considered the primary pollinators of *I. pandurata* because they transfer pollen to the stigmas with each flower visit, and usually have two hours to visit flowers and transfer pollen before other visitors appear. Other visitors serve as occasional pollinators.

Ipomoea pandurata, Relatives and Other Bees

The closest relative of *I. pandurata* in the United States is *I. leptophylla* Torrey. Ranges of these two plants overlap in eastern Oklahoma and northeastern Texas. In the area of overlap is a rare population, *I. shumardiana* (Torrey) Shinners. Robert Pearce has proposed that this population is the

result of hybridization between *I. pandurata* and *I. leptophylla* (Shinners *in* Correll and Johnston, 1970).

Ipomoea leptophylla is a prairie species known to range from southeastern Montana south into Texas. This plant was studied by Linsley (1960) near Los Montoyas, New Mexico. Linsley found *Melitoma grisella* (Cockerell and Porter), a matinal pollen collector, to be the major visitor and pollinator of this species. Three other genera of bees visit *I. leptophylla*, but their visits were for nectar only and no pollen was collected. *Melitoma grisella* is the only *Ipomoea* oligolege found in the northern part of the range of the plants.

In the small area of range overlap of *I. pandurata* and *I. leptophylla* in Oklahoma and Texas, there is also an overlap of *Melitoma taurea* and *M. grisella*. If hybridization is the origin for the plants named *I. shumardiana*, either of these bees or *Bombus* could be responsible for the crossing.

Ipomoea longifolia Bentham is known from two border counties in Arizona south to the state of Queretaro, Mexico. Linsley et al. (1956), Butler (1967) and Cazier and Linsley (1974) studied this species and found two oligolectic bees associated with the plants. Most closely allied with *I. longifolia* is the bee *Ptilothrix sumichrasti* (Cresson); also gathering pollen was *Melitoma segmentaria* (Fabricius) (= *Melitoma euglossoides* Lepeltier and Serville). Exhaustive study of the biology of this *Ptilothrix* indicates that the species is oligolectic to *I. longifolia* as long as the plant is flowering (Linsley et al., 1956; Linsley and MacSwain, 1958; Michener, 1974; Torchio, 1974). The *Ptilothrix* is not as species-specific as *Cemolobus* but takes pollen from other *Ipomoea* species when *I. longifolia* has finished its blooming season. *Ipomoea pringlei* Gray is the species noted to be visited by both *Ptilothrix* and *Melitoma* as the flowering season of *I. longifolia* ends.

Summary.—The data show that two species of bees have specific requirements for *Ipomoea* pollen in the eastern United States. *Cemolobus ipomoeae* is specific in pollen collecting habits and uses only *I. pandurata* pollen. Both the plants and the bees are endemic to the deciduous forest areas of the eastern United States. *Melitoma taurea* is found in the same region, but is less specific in pollen collecting as it takes pollen from several species of *Ipomoea*.

Related to *I. pandurata* is the prairie species *I. leptophylla*. Present data indicate that this plant is closely linked with *Melitoma grisella*. At present it is not possible to determine whether *I. shumardiana* is a hybrid between *I. pandurata* and *I. leptophylla*.

The closest relative to *I. leptophylla* and *I. pandurata* is the Arizonan and Mexican species *I. longifolia*. *Ptilothrix sumichrasti* is oligolectic to *I. longifolia*, however, the relationship is somewhat different from the other United States species. As long as *I. longifolia* is in flower, this *Ptilothrix* uses pollen only from that species. When this *Ipomoea* stops flowering, the bees shift to another species.

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Literature Cited

Baker, H., and P. D. Hurd, Jr. 1968. Intrafloral ecology. Annu. Rev. Entomol. 13:385–414.

Britton, N. L., and A. Brown. 1898. An illustrated flora of the northern United States, Canada and the British possessions. Vol. III. Scribner's Sons, New York.

Brown, C. A. 1972. Wildflowers of Louisiana and adjoining states. Louisiana State Univ. Press, Baton Rouge.

Butler, G. D., Jr. 1967. Biological observations on *Ptilothrix sumichrasti* (Cresson) in southern Arizona. Pan-Pac. Entomol. 43:8–14.

Cazier, M. A., and E. G. Linsley. 1974. Foraging behavior of some bees and wasps at *Kallstroemia grandiflora* flowers in southern Arizona and New Mexico. Am. Mus. Novit. 2546:1–20.

Conard, H. S. 1969. Plants of central Florida. Ridge Audubon Soc., Lake Wales.

Correll, D. M., and M. C. Johnston. 1970. Manual of the vascular flora of Texas. Texas Research Foundation, Renner.

Deam, C. C. 1940. Flora of Indiana. Indianapolis.

Ellis, W. H., and E. W. Chester. 1973. Summer and fall wildflowers of land between the lakes. Austin Peay State Univ., Clarksville.

Faegri, K., and L. van der Pijl. 1966. The principles of pollination ecology. Pergamon Press, Oxford.

Fernald, M. L. 1950. Gray's manual of botany, ed. 8. Boston.

Gleason, H. A., and A. Cronquist. 1963. Manual of the vascular plants of northeastern United States and adjacent Canada. D. van Nostrand, Princeton.

Hurd, P. D. Jr., E. G. Linsley, and T. W. Whitaker. 1971. Squash and gourd bees (*Peponapis*, *Xenoglossa*) and the origin of the cultivated *Cucurbita*. Evolution 25:218–234.

Jones, G. N., G. D. Fuller, H. E. Ahles, G. S. Winterringer, and A. Flynn. 1955. Vascular plants of Illinois. Mus. Sci. Ser. Vol. VI., Univ. Illinois Press, Urbana.

Justice, W. S., and C. R. Bell. 1968. Wildflowers of North Carolina. Univ. North Carolina Press, Chapel Hill.

Kearney, T. H., and R. H. Peebles. 1951. Arizona flora. Univ. California Press, Berkeley.

———. 1961. Arizona flora, ed. 2. Univ. California Press, Berkeley.

Lanjouw, J., and F. A. Stafleu. 1959. Index herbariorum. Regnum Veg. 15:1–249.

Linsley, E. G. 1960. Observations on some matinal bees at flowers of *Cucurbita*, *Ipomoea* and *Datura* in desert areas of New Mexico and southeastern Arizona. J. N.Y. Entomol. Soc. 68:13–20.

Linsley, E. G., and J. W. MacSwain. 1958. The significance of floral constancy among bees of the genus *Diadasia* (Hymenoptera, Anthophoridae). Evolution 12:219–223.

Linsley, E. G., J. W. MacSwain, and R. F. Smith. 1956. Biological observations on *Ptilothrix sumichrasti* (Cresson) and related groups of Emphorine bees. Bull. South. Calif. Acad. Sci. 55:83–101.

Michener, C. B. 1954. Bees of Panamá. Bull. Am. Mus. Nat. Hist. 104:1–175.

———. 1974. Further notes on nests of *Ancyloscelis*. J. Kans. Entomol. Soc. 47: 19–22.

———. 1975. Nests of *Paranthidium jugatorium* in association with *Melitoma taurea* (Hymenoptera: Megachilidae and Anthophoridae). J. Kans. Entomol. Soc. 48: 194–200.

Mitchell, T. B. 1960. Bees of the eastern United States. Vol. I. N.C. Agric. Exp. Stn. Tech. Bull. 141:1–538.

———. 1962. Bees of the eastern United States. Vol. II. N.C. Agric. Exp. Stn. Tech. Bull. 152:1–557.

Mohlenbrock, R. H., and J. W. Voight. 1959. A flora of southern Illinois. S. Illinois Univ. Press, Carbondale.

Muesebeck, C. F. W., K. V. Krombein, and H. K. Townes. 1951. Hymenoptera of America north of Mexico. Synoptic Catalog. USDA Agric. Monogr. No. 2.

Radford, A. E., H. E. Ahles, and C. R. Bell. 1968. Manual of the vascular flora of the Carolinas. Univ. North Carolina Press, Chapel Hill.

Robertson, C. 1891. Flowers and insects, Asclepiadaceae to Scrophulariaceae. Trans. St. Louis Acad. Sci. 5:569–598.

———. 1925a. Heterotropic bees. Ecology 6:412–436.

———. 1925b. Habits of the *Hibiscus* bee, *Emphor bombiformis*. Psyche 32:278–282.

———. 1928. Flowers and insects. Published privately, Carlinville, Illinois.

———. 1929. Phenology of oligolectic bees and favorite flowers. Psyche 36:112–118.

Small, J. K. 1903. Flora of the southeastern United States. Published by the author, New York.

———. 1933. Manual of the southeastern flora. Univ. North Carolina Press, Chapel Hill.

Steyermark, J. A. 1963. Flora of Missouri. Iowa State Univ. Press, Ames.

Tidestrom, I., and Sister T. Kittell. 1941. Flora of Arizona and New Mexico. Catholic Univ. of America Press.

Torchio, P. F. 1974. Notes on the biology of *Ancyloscelis armata* Smith and comparisons with other Anthophorine bees (Hymenoptera: Anthophoridae). J. Kans. Entomol. Soc. 47:54–63.

Wharton, M. E., and R. W. Barbour. 1971. A guide to the wildflowers and ferns of Kentucky. Univ. Press of Kentucky, Lexington.

Wooten, E. O., and P. C. Standley. 1915. Flora of New Mexico. Contrib. U.S. Nat. Herb. 19:514–519.

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Footnote

[1] Oligolectic, as used here, refers to bees whose females utilize pollen from one or a few species of plants as food for their young. This usage conforms to that by Robertson (1929), Michener (1954), Linsley & MacSwain (1958), Faegri and van der Pijl (1966) and Baker and Hurd (1968) among others. Some biologists object to such usage since it ignores adult male activities.